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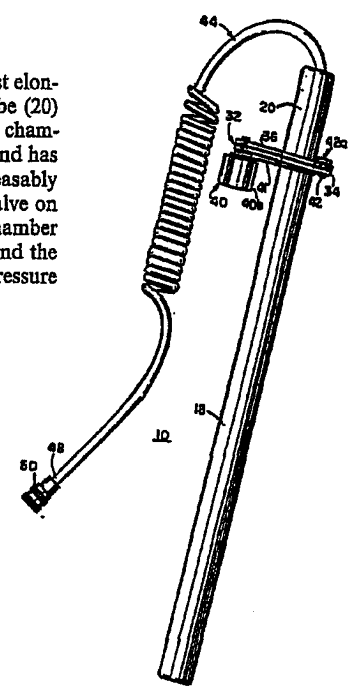
(57) Abstract

An air pump (10) particularly suitable for use with bicycles includes a first elongated tube (18) to form a pump chamber and housing, a second elongated tube (20) coupled with a piston in the first tube to reciprocate the piston within the pump chamber. A flexible hose (44) extends from the piston and through the second tube and has at its exposed end an air valve coupling (50). The first and second tubes are releasably secured to permit use of the pump as a seat post. The pump includes a first valve on the outside of the piston between atmosphere and a closed end of the pump chamber and a second valve inside the piston between the closed end of the chamber and the flexible hose. The first valve is configured to provide greater seal effect as pressure builds in the closed end of the pump chamber.



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PUMP

The invention relates to pumps and, in particular, to air pumps suitable for manual manipulation and internal installation in bicycles.

Manually actuable air pumps have been devised for use with bicycles. A large number of these air pumps use a portion of the bicycle frame as the pump housing and chamber. The major advantage provided by most of these pumps is that they permit manual operation of the pump without having to remove the pump from the bicycle. In many cases, the seat is coupled with an arm of the pump carrying the pump piston to permit reciprocation of the pump piston.

These types of pumps suffer from several disadvantages. First, the pump is not removable from the bicycle itself since the frame forms a portion of the pump. In many cases such pumps include components which are mounted within the frame members that are brazed or welded together, making subsequent access to the components for repair difficult or impossible without adversely affecting the frame or the finish of the bike. The tubing used in most bicycle frames tends to be rather thin and of average commercial quality. Such tubing is weakened and subject to corrosion in areas where it is penetrated, for example to provide air pump fittings.

A lesser number of air pumps designed for use with bicycles include separate pump housings which may be removed from a bicycle frame receiving the pump. The major disadvantage of such pumps is that they must be removed from the bicycle frame to permit operation.

Another major disadvantage of the manually operated air pumps is their limited pressure capability. Virtually all such pumps use for piston sealing, a flexible diaphragm which permits air to pass

when a partial suction is created within the pump chamber and prevents blowby when air is being compressed in the pump chamber. However, this design has a maximum pressure capability of about 100 psi or less before compressed air blowby will occur.

In one aspect, the invention is a manually-operable air pump comprising a housing containing a pump chamber having a closed end, a piston assembly including a piston within the chamber, a connecting arm having a first end coupled with the piston and an opposing second end, and an air passage extending generally axially through the piston. The pump further comprises means coupled with the connecting arm for manually reciprocating the piston in the chamber, a first, one-way valve means on the piston for compressing air in the closed end of the chamber when the piston is moved in a first axial direction and for permitting air to enter the closed end of the chamber when the piston is moved in an axial direction away from the closed end of the chamber, and a second, one-way valve means for permitting air to pass from the chamber into the air passage when the piston is being moved in the first axial direction and for preventing air from passing through the air passage into the chamber when the piston is moved in the opposite direction.

In another aspect, the invention includes a high-pressure manually operable pump comprising a housing including a pump chamber, a piston in the chamber, manual actuating means coupled with the piston for reciprocating the piston within the chamber, and one-way valve means on the piston. The one-way valve means includes an annular valve member and groove means extending circumferentially around an outer surface of the piston for receiving the annular valve member on the piston. A portion of the groove means has an axial dimension greater than a maximum axial dimension of an adjoining portion of the valve member to permit axial

movement of the adjoining portion of the valve member along the portion of the groove means in the axial direction to open the one-way valve means and allow fluid to pass through the one-way means. The one-way valve means further includes a tapered annular valve seat at one axial end of the groove means. The one-way valve means closes when the annular valve member seats on the tapered valve seat.

In another aspect, the invention is a bicycle air pump which comprises a first elongated tube having a length and outer diameter sufficient for removable receipt in a seat tube of a bicycle frame. It further comprises a second elongated tube having a length less than the first tube length and an outer diameter less than the first tube outer diameter, the length and outer diameter of the second tube being sufficient for removable receipt and clamping of the second tube in a seat post collar of a bicycle seat. One of the first and second tubes forms a pump chamber and the remaining tube is coupled with a piston in the pump chamber for reciprocating the piston. The pump further comprises means for releasably securing together the first and second elongated tubes, a flexible air hose extending from the second elongated tube and an air valve coupling at an exposed end of the air hose.

In the drawings:

Fig. 1 is an isometric view of a first embodiment of a manually operable air pump mounted on a bicycle;

Fig. 2 is a side elevational of the air pump of Fig. 1 removed from the bicycle;

Fig. 3 is a cross-sectional elevation of the pump of Figs. 1 and 2 during a compression stroke;

Fig. 4 is a cross-sectional elevation similar to Fig. 3 during a refill stroke;

Fig. 5 is an enlarged side section of an air valve connector of the pump of Figs. 1-4;

Fig. 6 is a cross-sectional elevation of a second embodiment of an air pump during a refill stroke;

Fig. 7 is a cross-sectional elevation of the pump of Fig. 6, taken along line 7-7 of Fig. 6, during a compression stroke;

Fig. 8 is a transverse cross-section of the pump taken along line 8-8 of Fig. 7 during a compression stroke;

Fig. 9 is a cross-sectional elevation of a third embodiment of an air pump during a refill stroke;

Fig. 10 is an end view of the air pump of Fig. 9 in a compression stroke;

Fig. 11 is a cross-sectional elevation of a fourth embodiment of an air pump during a refill stroke;

Fig. 12 is an end view of the air pump embodiment shown in Fig. 11 in a compression stroke;

Fig. 13 is a cross-sectional elevation of a fifth embodiment of an air pump during a refill stroke; and

Fig. 14 is a cross-sectional elevation of a fifth embodiment of an air pump during a compression stroke.

Figs. 1 through 5 depict a first embodiment of a high pressure, manually-operable air pump 10 mounted on a bicycle 12. The air pump 10 is used as the seat post coupling the seat 14 to the bike frame 16. A lower end of the pump 10 is received in the seat tube 26 of the frame 12 and is clamped in the frame 12 with the collar 28 provided at the mouth of the seat tube 26. The upper end of the pump 10 is received and clamped in the seat post collar 30 (Fig. 1) of the seat 14.

Referring to Fig. 2, the pump 10 includes a first elongated tube 18 and a second elongated tube 20, shorter than and coaxial with the first tube 18. The first tube 18 has an outer diameter sufficient to permit that tube to be removably received in the seat tube 26 of the frame 16 and clamped to the frame by a collar 28 (Fig. 1). Preferably, the outer diameter of the tube 10 is between about seven-eights and one inch. The first tube 18 has a length sufficient to permit adequate height adjustment of the seat 14, preferably about twelve inches.

The second tube 20 has an outer diameter less than the outer diameter of the first tube 18 and sufficient to permit that tube to be removably received and clamped in the seat post collar 30 of seat 14, between about seven and eight-tenths of an inch. The second tube 20 need only be sufficiently long to permit it to be received in the seat post collar 30 and thus a length shorter than the first tube length, preferably about two and one-half inches or less.

Means 32 are provided for releasably fixedly securing together the first and second elongated tubes 18 and 20 in a manner to prevent relative translational or rotational movement of the elongated tubes 18 and 20. The means 32 comprises a first mating member or first elongated planar flange 34, which protrudes radially outwardly from an end of the first tube 18. Means 32 further comprises a second mating member in the form of a second, identically elongated planar flange 36 protruding radially outwardly at an end of the second tube 20. The planar flanges are parallel to one another to permit their joining together. Each of the first and second flanges 34, 36 is fixedly secured to a first or second tube 18, 20, by conventional means such as brazing or welding 68. A first, removable fastener 40, a flexible support 41, a second fixed fastener 42 and a flexible hose 44 having at its exposed end 48 an air valve coupling 50 are further depicted in Fig 2.

Referring to Figs. 3 and 4, the first elongated tube 18 constitutes a housing of the pump and defines a cylindrical pump chamber 52 therein having a closed end 54. A piston assembly 56 includes a piston 58 within the chamber 52, a connecting arm 60 having a first end 62 coupled with the piston 58 and an opposing second end 64, and an air passage 66 extending axially through the piston 58. The passage continues through the connecting arm 60. The second end 64 of the connecting arm 60 is fixedly coupled with the second flange member

36 by suitable means such by threading. The second flange member 36 in turn fixedly supports the second elongated tube 20 such as by welds 68. The second flange member 36 and the second elongated tube 20 provide means for gripping the connecting arm 60 and manually reciprocating the piston 58 in the chamber 52. A first, one-way valve means 70 on the piston 58 and a second, one-way valve means 88 along the air passage 66 are provided. The first valve means 70 opens to permit air to pass around the piston 58 into the closed end 54 of chamber 52 and closes for compressing air in the closed end of the chamber. The second valve means 88 opens to permit air being compressed in the closed end 54 of the chamber to pass into the air passage 66 when pressure of the air in the closed end exceeds that in the air passage and closes to prevent air from passing from the air passage 66 into the chamber 52 when pressure in the air passage exceeds the pressure in the closed end 54.

The first valve means 70 comprises an annular O-ring valve member 72 and groove means for receiving the annular valve member 72 on the piston 58. The groove means comprises a primary or first groove 74 and a pair of secondary grooves 84. The first groove 74 extends circumferentially around an outer surface of the piston 58 and receives the annular valve member 72. The first groove 74 is symmetric with respect to at least one radial and to all axial planes and has an axial dimension which is greater than the maximum axial dimension of the annular valve member 72 to permit axial movement of the valve member 72 along the first groove 74. The piston 58 is fabricated from first and second annular components 76, 78 which are attached by threading to the first end 62 of the connecting arm 64. One annular component 76 has one end of reduced diameter which forms the bottom of the first groove 74. The remainder of the component 76 is of a greater diameter and forms a land 83 defining one side or end

of the first groove 74. The other annular component 78 includes a beveled circumferential surface 82 adjoining and facing the reduced diameter end of the first component 76. The beveled surface 82 forms a seat for the annular valve member 72 and tapers outwardly. Surface 82 is located at an end of the groove means which is distal to the closed end 54 of the chamber 52. The seat 82 and land 83 retain the O-ring 72 in the first groove 74 and on the piston 58. Opposing secondary grooves 84 extend axially along the circumferential surface of the first annular component 76 beneath the first groove 74 and define passages extending through the land 83. These secondary grooves 84 define a portion of the groove means which is configured to permit air to pass through the first valve means 70 beneath the annular valve member 72 and through the piston 58, when the valve member 72 moves axially along the first groove 74 away from the valve seat surface 82. This will occur when the piston 58 is moved away from the closed end 54 of the chamber 52.

A first end 46 of the flexible hose 44 is passed through the arm 60 by an annular insert 86 which clamps the end of the hose between the insert 86 and the inner surface of the connecting arm 60. The outer surface of the insert 86 is finished, for example, by threading, to better grip the first end 46 of the hose 44. The first end 46 of the hose 44 is fixedly coupled with the piston assembly 56 and the second tube 20 and pneumatically coupled with the air passage 66 in the piston 58.

Referring to Fig. 4, the insert 86 forms one end of the second, one-way valve means 88 located along the air passage 66. The remainder of the second valve means 88 is provided by an interior chamber 90, which is formed in the first annular component 76, an elastic O-ring 92, which forms a seat of the valve means 88, and a movable valve member or sphere 94.

Fig. 3 further depicts means 32 for fixedly securing the first and second elongated tubes together. The means 32 includes first and second flanges 34, 36, first and second fasteners 40, 42, an unthreaded bore 96 through the first flange member 34 and a threaded bore 98 through the second flange member 36. The threaded bore 98 aligns with the unthreaded bore 96 for receiving a threaded portion 40a of the fastener 40 for fixedly securing together the mated first and second flange members 34, 36 in a removable fashion. The second fastener 42 is a rivet extending fixedly through the first flange 34 on a side of the tubes 18 and 20 diametrically opposed to the first fastener 40. A portion of the rivet is received in a cut-out 36a, which is exposed on a side of the second flange 36, when the flanges 34, 36 rotate to align the bores 96, 98. Head portion 42a at the rivet 42 and the first flange 34 prevent relative axial movement of the second flange 36 thereby securing the tubes 18, 20 together. The first and second fasteners 40, 42 on opposing sides of the tubes 18, 20 prevent bending of the pump at the flanges 34, 36.

The open end of the first elongated tube 18 opposite closed end 54, can be partially closed by a third annular component 100, which includes a central bore 102 to permit extension of the second end 64 of the arm 60 from the first tube 18, and an additional bore 104, which permits the free passage of air into and out of the first tube 18. The component 100 prevents debris from entering the first tube 18 and may provide some support and guidance to the arm 60.

Fig. 5 shows a preferred configuration for the air valve connector 50. The connector 50 is mounted at a second end 48 of the flexible hose 44 and includes a central tubular member 106,
one end of which has a conically tapered outer surface 108 which is inserted into the end 48 of hose 44. A fastening member 112 is clamped over the end 48 and one

end of central member 106 fastens the connector 50 to the hose 44. A threaded collar 114 is rotatably supported at the remaining end of the central tubular member 106. The threaded collar 114 is sized to be received by a conventional air valve stem for coupling the flexible hose 44 to the stem. An annular O-ring sealing gasket 118 is provided. It is noted that unlike most conventional air valve connectors, the connector 50 of the present invention lacks a central stalk or other solid structure for depressing the air valve in the valve stem. This is because the pump 10 is capable of compressing air sufficiently to force depression of an air valve without physically contacting that valve.

The tubes 18, 20 of the pump 10 can be constructed of suitable material with suitable dimensions, for example, about 1018 to 1027 mild steel seamless tubing, with about 50 mil wall thickness, so as to permit use of the pump 10 as the seat post for supporting a conventionally constructed bicycle seat 14 on a conventionally constructed bike frame 16.

The pump 10 may be used by removing the flexible hose 44 from the storage bag 15 (Fig. 1) and then attaching the air valve connector 50 to a conventional threaded air valve stem. The fastener 40 is unscrewed from the second flange 36 and the tubes 18 and 20 rotated to free rivet 42 from flange 36. The second tube 20, still fixedly secured to the seat 14, may be raised and lowered by raising and lowering the seat 14 while the pump is still mounted on the bicycle 12 to reciprocate the piston 58 along the chamber 52. After use, rivet 42 and cutout 36a may be engaged and the threaded portion 40a of fastener 40 may again be passed through unthreaded opening 96 into the threaded bore 98 for securing the first and second tubes 18, 20 together.

The pump 10 may be installed as a seat post in and subsequently removed from any number of conventional

bicycles, without alterations to either the bicycles or their seats.

Fig. 3 depicts the positions of the first and second valve means 70, 88 during a compression stroke when the piston assembly 56 is being moved in a first axial direction into the first tube 18 and towards the closed end 54 of the chamber 52. Fig. 4 depicts the configuration of the two valve means 70, 88 during a reciprocal, refill stroke when the piston 58 is being moved in an opposing axial direction.

Referring to Figs. 3 and 4, during the compression stroke, air is compressed by the piston 58 in the closed end 54 of the chamber 52 by the first valve means 70. The O-ring valve member 72 tends to drag slightly on the inner wall of chamber 52 during movement of the piston 58 towards the closed end 54, seating on the tapered valve seat 82 thereby sealing the closed end of the chamber and closing the first valve means. As the piston continues to move, the O-ring is dragged by friction with the chamber wall and forced by the air being compressed farther out along the valve seat 82. The tapered surface of the seat 82 forces the O-ring 72 to expand radially outwardly and further into contact with the inner circumferential surface of the chamber 52. As the pressure of the air being compressed by the piston 58 builds up, the O-ring 73 is pressed increasingly harder onto the valve seat 82 and farther into the narrowing gap 120 formed between the beveled surface of the seat 82 and the inner circumferential surface of the chamber 52. This increases the sealing effect and permits the pump to compress air to pressures of up to at least about two hundred psi.

The first tube 18 defines both a housing and the cylindrical pump chamber. Since the optimum outer diameter of the first tube 18 must be sufficiently large to permit the tube to be clamped within a seat tube collar 28, the diameter of the cylindrical chamber

may be reduced, thereby reducing the cross-sectional area of the chamber 52 and total force which must be applied to the piston assembly 56 to achieve a given compression, by the use of the second elongated tube (not depicted) within the first elongated tube 18.

During the compression stroke, the valve member sphere 94 of the second valve means 88 is eventually forced from the surface of the O-ring 92 when the pressure of the air being compressed exceeds the pressure of the air in the air passage 66, thereby permitting compressed air to pass from the chamber 52 into the air passage 66.

During the refill stroke, the piston 58 is moved in an opposing axial direction. Friction between the O-ring valve member 72 and the inner circumferential surface of the chamber 52 causes the member 72 to move away from the beveled seat 82 and over the axially extending grooves 84, thereby permitting air, which enters through the bore 104 to pass by the piston 58 through the secondary grooves 84 and into the closed chamber end 54. At the same time, the compressed air in the air passage 66 and/or any partial vacuum created at the closed end 54 causes the sphere 94 to be received in the seat provided by O-ring 92, thereby preventing air from passing through the air passage 66 into the chamber 52.

It would be possible, though less desirable, to provide an inelastic annular valve member, for example, one of PTFE or nylon, and an elastically deformable, tapered valve seat 82 which is radially outwardly expanded into contact with the inner circumferential surface of the chamber 52 when the valve member 72 is seated against the valve seat 82 by compressed air in the chamber 52 for sealing the annular gap 120.

Figs. 6-8 depict, in varying views, a second configuration of the piston assembly, 56' of the pump 10. The piston assembly 56' includes a one-piece piston 77' and a modified annular insert 86' for

coupling a connecting arm 60' and first end of the flexible hose 44 to the piston 77'. The components 77', 60', 44 and 86' are all sized to form a compression friction fit securing the first end of the flexible hose 44 and one end of the arm 60' between the annular plug member 86' and a concentric collar portion of the piston 77'.

The embodiment of Figs. 6-8 comprises a modified first air valve means 70'. The modified valve means 70' includes groove means with a first groove 74' in an outer circumferential surface of the piston 77', a tapered, frustoconical valve seat 82', formed in the piston 77' and defining an end of the first groove 74' and an annular valve member 72 provided by an elastic O-ring. Land means are provided by a pair of diametrically opposed lands 83' at the end of the piston 77'. The axial length of the first groove 74' between the tapered valve seat 82 and the lands 83', is no more than slightly more than the axial dimension of the O-ring 72. At two symmetrically located positions, the first groove 74' is extended axially along the piston 77' between the lands 83' to an end of the piston 77' proximate the closed end 54 to form secondary grooves 84'. The secondary grooves 84' have an axial length greater than the maximum axial dimension of the adjoining O-ring valve member 72.

Operation of the piston assembly 56' in a refill stroke is illustrated in Fig. 6. The secondary grooves 84' permit axial movement of the adjoining portions of the O-ring valve member 72 along those portions of the groove means when the piston assembly 56' is moved away from the closed end 54. During such movement, the portions of the O-ring 72 adjoining the secondary grooves 84' are retarded by frictional contact with the inner cylindrical surface of the chamber 52 defined by first tube 18 and/or a partial vacuum created at the closed end 54 through the operation of the second valve means 88, which causes those portions of the O-ring 72

to move away from the valve seat 82, breaking the air seal in those regions between the piston 77' and the inner circumferential surface of the chamber 52. The elastic O-ring 72 will continue to stretch towards the closed end 54 until sufficient clearance is provided between it, the piston 77' and inner circumferential wall of the chamber 52 to permit air to pass through the secondary grooves 84' into the closed end of the chamber 52. To minimize the flexure of the O-ring, the piston 77' can be undercut in a radial direction more deeply in the secondary groove areas 84' than in the fully circumferential area of the first groove 74, so that a greater space is formed between the outer surface of the piston in the secondary groove areas 84' and the inner circumferential surface of the chamber 52.

As shown in Fig. 7, before pumping begins, the O-ring 72 will lie entirely in the first groove portion 74' of the groove means. Following a refill stroke (Fig. 6), elasticity of the stretched O-ring 72 will assist in moving the O-ring entirely into the first groove portion 74' to initially close the first valve means 70'. Air in the closed end 54 is trapped by the piston 77' and first valve means 70' and compressed. The compressed air bears against the O-ring 72 compressing it against the tapered valve seat 82 which expands the O-ring radially outwardly while directing the O-ring deeper and more completely into the annular gap provided between the piston 77' and the inner circumferential surface of the first elongated tube 18. The one-piece piston construction of the second embodiment of Figs. 6-6 is simpler, more efficient and less expensive to manufacture and assemble than the multipiece piston construction of Figs. 1-5.

The third piston assembly 156 (Fig. 9) includes a piston 158 receiving on one side a smooth end of a connecting arm 60' and one end of hose 44. The ends of

the connecting arm 60' and flexible hose 44 are held within a cylindrical portion 179 of the piston 158 by means of an insert 186 which is provided with a flared head 187. The piston head 177 is monolithic and formed from easily worked materials such as thermoplastic. First one-way valve means 170 is provided on the outer circumferential surface of the piston head 177 by a first, circumferential groove 174 which receives an annular valve member such as an elastic O-ring 72. The first, one-way valve means 170 compresses air in the closed end of the chamber 52 when the piston 158 is moved in a first axial direction. One side of the first groove 174 is formed by a circumferential surface 182, forming a seat for O-ring 72. The opposing axial end of the first groove 174 is provided by a land 183 which extends entirely around the circumference of the piston head 177 except at and adjoining a point where a secondary groove 184 is provided underlying the first groove 174 and extending from beneath the first groove 174 to the axial end of the piston 158. This break in the land 183 is best seen in Fig. 10. Second, one-way valve means 88 and air passage 66 are provided.

The extension of the land 183 almost completely around the circumference of the piston 158 and the relatively small portion of the land 183 which is eliminated about the secondary groove 184 minimizes the portion of the O-ring 72 which is permitted to move axially past the land 183 and which is subject to fatigue in use. The axial extent of the secondary groove 184 is relatively greater so that the slightest movement of the O-ring 72 from the valve seat 182 provides an immediate opening around the O-ring 72 and into the closed end of the chamber 52.

In a fourth embodiment in Figs. 11, 12, the piston 258 includes a cylindrical portion 279 receiving ends of the connecting arms 60' and the flexible tube 44 and further receiving the insert 186 with flared head 187. The piston 258 further includes an annular head portion

277 having an outer circumference slightly less than the inner circumference of the tube 18 forming the chamber 52 to permit air to pass therearound. Supported coaxially from the head 277, facing towards the closed end of the chamber 52, is an annular stalk 281 having at its extreme axial end a pair of radially outwardly extending lands 283 (see Fig. 12). The lands 283 retain an annular valve member 272 on the annular stalk 281 permitting movement of that valve member towards and away from a planar surface 282 on a facing side of the piston head 277. When the valve member 272 is pressed against the planar surface 282, a large sealing surface area is provided between the valve member 272 on the surface 282, preventing air from passing through the central opening 284 and the outer circumferential surface of the stalk 281. The opening 284 is larger than the cross-section of the stalk 281, permitting air to pass therebetween when the valve member 272 moves away from the planar surface 282. The portion of the stalk 281 between the planar surface 282 and the lands 283 constitute the first groove of the groove means while the flats 285 at the ends of the stalk 281 constitute the second groove means. While this embodiment lacks a beveled valve seat, the relatively large seat formed by the planar surface 282 acts in a similar fashion. The greater the air pressure in the closed end of the pump chamber 52, the greater the force on the valve member 272 and the more effective the seal between it and the planar surface 282. The valve member 272 further includes a skirt 273 extending towards the closed end of the chamber 52 and flaring radially outwardly as it tapers in thickness. Skirt 273 completes the sealing between member 272 and the inner wall of the tube 18. The skirt 273 provides a concavity to the valve member 272 facing the closed end of chamber 52. Second, one-way valve means 88 is provided axially within the piston assembly 156 along air passage 66.

The embodiment of Figs. 11-12 provides a beneficial result in that pressure of the air in the closed end of the chamber 52 forces the annular member 272 of the first valve means more securely against the piston 258. Because air passes through the center of the valve member 272 rather than along its edges, the valve member 272 can be made much more rigid than the prior art flexible rubber or leather diaphragms. The annular valve member 272 need not be elastic, but merely resilient and long wearing. The axial length of the skirt 273 and the generally concave shape of the valve member 272 facing the closed end further contribute to the sealing effect between the skirt 273 and the side wall of the tube 18.

Figs. 13 and 14 depict refill and compression strokes, respectively, in a fifth embodiment illustrated by piston assembly 356. The piston assembly 356 includes piston 358 and connecting arm 60'.

A cylindrical end 379 receives one end of the connecting arm 60' and an end of the flexible air hose 44 which are compressibly and frictionally held within the cylindrical end 279 by the annular member 186. The piston 358 further includes an annular head portion 377 having an outer circumference slightly less than the inner circumference of the tube 18. Supported coaxially from the head 377, is an annular stalk 381 having at its extreme axial end land means in the form of a removable spring clip 383. The clip 383 is received in a circumferential groove 386 on stalk 381 and retains an annular member 372 on piston 258. An elastomeric O-ring 302 is received in a groove 304 extending circumferentially around the member 372. The axial end of the groove 304, includes a tapered annular surface 306. The annular member 327 includes a central opening 308, slightly larger than the radial dimensions of the stalk 381 to permit air to pass between the stalk 381 and the annular member 372. The annular

member 372 includes another tapered annular surface 312 extending about the central bore 308. An O-ring 320 is carried around the base of the stalk 381 where the stalk 381 intersects the planar surface 382 which does not move and effectively constitutes part of piston 358. The O-ring 320 contacts the annular tapered surface 312 when the piston head 377 is pressed against the annular member 372. A first valve means 370 is formed by the head 377 and O-ring 320 of piston 358 and the annular member 372 and O-ring 302 for compressing air when the piston 358 is moved in a first axial direction and for permitting air to enter the chamber 52 when the piston 358 is moved in an opposing axial direction (Fig. 13). The annular member 372 is thus captured on the stalk 381 between the clip 383 and the head 377 of the piston 358 and functions as a floating valve seat while the piston head 377 and its carried O-ring 320 operate as a valve. First groove means is provided by stalk 381 between surface 382 and clip 383.

Openings between leg 384 and a symmetric leg (not seen) of the clip pin 383 and opening 385 at the bight end of the clip 383 permit air to pass through the pin 383 even when the annular member 372 is pressed firmly against the pin 383 during the refill of the piston 358 and constitute second groove means on the first valve means 370.

Second, one-way valve means 388 is provided axially through the piston 358 for permitting air to pass from the closed end 54 of the chamber 52 into the air passage 66 when the piston 358 is being moved in the first axial direction and for preventing air from passing through the air passage 66 into the chamber 52 when the piston 358 is being moved in the second axial direction. In this embodiment, a beveled annular valve seat 392 is employed.

During an upstroke, member 372 initially remains stationary on the inner circumferential surface of the first tube 18 until it is contacted by clip 383.

O-ring 302 causes that member 372 to continue to lag on clip 383 while the piston 358 is raised. Air then is free to pass between the outer circumferential surface of the head 377 and the inner circumferential surface of the tube 18, between the planar surface 382 and the facing surface of the annular member 372 and along the bore 308 between the inner circumferential surface of that bore and the outer surface of the piston stalk 381. At the same time, compressed air in passage 66 and/or the partial vacuum formed in the chamber 52 causes the second, one-way valve means 388 to close.

During a compression stoke, the piston head 377 is moved towards the closed end 54 of the chamber until the O-ring 320 on the stalk 381 contacts the opposing beveled surface 312 of the annular member 372 closing the first, one-way valve means 370. Further movement of the piston 358 toward the closed end compresses the air. This air bears against the O-ring 302 forcing that O-ring against the beveled surface 306 thereby increasing the sealing effect. The buildup in air pressure further forces the O-ring 320 into the narrowing gap formed by the tapered annular surface 312 and the opposing planar surface 382 of the piston head 377. Spherical valve member 94 is eventually forced from tapered seat 392 opening the second valve means 388 permitting the compressed air to pass into the air passage means 66. Air pressures of about 150 psi or more can be developed.

CLAIMS:

1. A manually-operable air pump suitable for use in a bicycle frame having a seat tube and a seat having a collar comprising:

a housing containing a pump chamber having a closed end;

a piston assembly including a piston within the chamber, a connecting arm having a first end coupled with the piston and a second end, and an air passage extending generally axially through the piston;

means coupled with the connecting arm for manually reciprocating the piston in the chamber;

first, one-way valve means on the piston for compressing air in the closed end of the chamber when the piston is moved in a first axial direction towards the closed end of the chamber and for permitting air to enter the closed end of the chamber when the piston is moved in a second axial direction away from the closed end of the chamber; and

second, one-way valve means for permitting air to pass from the chamber into the air passage when the piston is being moved in the first axial direction and for preventing air from passing through the air passage into the chamber when the piston is being moved in the second axial direction.

2. The pump of claim 1 wherein the housing has an outer diameter sufficient to be removably received in the seat tube.

3. The pump of claim 2 wherein the means for manually reciprocating comprises a second elongated tube having an outer diameter sufficient to permit the second tube to be removably received and clamped in the seat collar.

4. The pump of claim 3 in combination with the bicycle seat clamped to the second tube.

5. The pump of claim 3 wherein the housing comprises a first elongated tube and comprising means

for releasably fixedly securing together the first and second elongated tubes.

6. The pump of claim 5 wherein the means for securing comprises a first mating member protruding radially from an end of the first tube, the first mating member limiting depth to which the first tube can be inserted into the seat tube.

7. The pump of claim 6 wherein the means for securing further comprises a second mating member coupled with the second tube, the first and second members being joined together.

8. The pump of claim 7 wherein the first and second mating members are first and second elongated planar flanges, respectively, wherein the means for securing comprises a first, removable fastener extending through the first and second flanges.

9. The pump of claim 8 wherein the means for securing comprises a second fastener extending through the first and second flanges on a side of the first and second elongated tubes opposite the first fastener.

10. The pump of claim 1 further comprising a flexible hose having a first end pneumatically coupled with the air passage, the flexible hose having a second end adapted to be connected to an air valve of a bicycle tire.

11. The pump of claim 10 further comprising an air valve connector at a second end of the flexible hose, the air valve connector lacking solid structure for depressing the air valve so that the air valve is depressed solely from compressed air in the flexible hose.

12. The pump of claim 1 wherein the first valve means comprises:

an annular member; and

groove means extending circumferentially around the piston for receiving the annular member, the groove means having an axial dimension greater than a maximum axial dimension of an adjoining portion of the annular

member to permit the adjoining portion of the annual member to move axially along the groove means sufficiently to permit air to pass through the first valve means along the groove means.

13. The pump of claim 12 wherein the first valve means further comprises a tapered annular seat on the piston for contacting the annular member and closing the first valve means.

14. The pump of claim 13 wherein the annular member comprises an elastically deformable O-ring.

15. A high pressure, manually operable pump comprising:

a housing including a pump chamber;

a piston in the chamber;

manual actuating means coupled with the piston for reciprocating the piston within the chamber; and

one-way valve means on the piston, the valve means including an annual member and groove means extending circumferentially around an outer surface of the piston for receiving the annular member on the piston, a portion of the groove means having an axial dimension greater than a maximum axial dimension to permit axial movement of the adjoining portion of the annular member along the portion of the groove means for allowing fluid to pass through the one-way valve means, a tapered annular surface on the piston, the one-way valve means closing when the annual member contacts the annular tapered surface.

16. The pump of claim 15 wherein the annular member is a valve member, and wherein the valve member is resiliently deformable so that when the valve member seats on the valve seat the valve member deforms radially outwardly for sealing an annular gap between the outer circumferential surface of the piston and an inner circumferential surface of the chamber.

17. The pump of claim 16 wherein the piston further comprises land means spaced from the valve seat

for retaining the valve member on the piston and wherein a portion of the groove means extends axially along the piston spanning the land means for permitting fluid to pass by the piston and across the land means through the one-way valve means.

18. The pump of claim 17 wherein the land means is positioned sufficiently close to the valve seat as to prevent axial movement of the valve member between the land means and the valve seat.

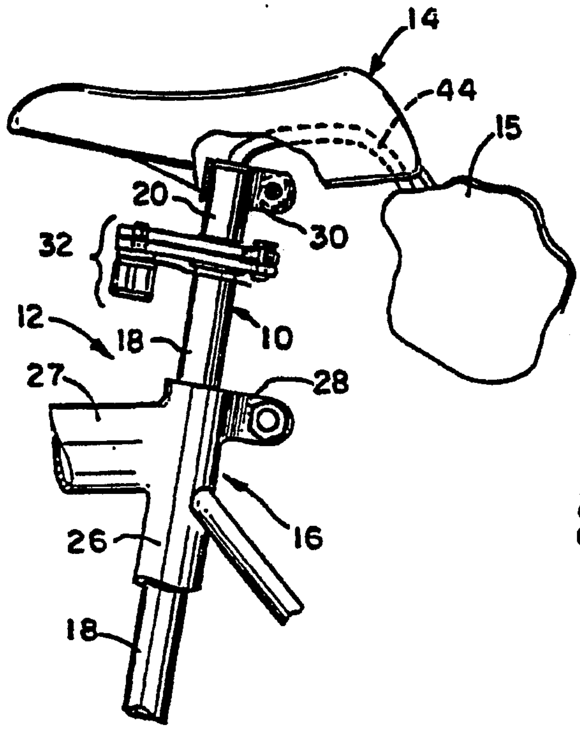
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FIG. 1

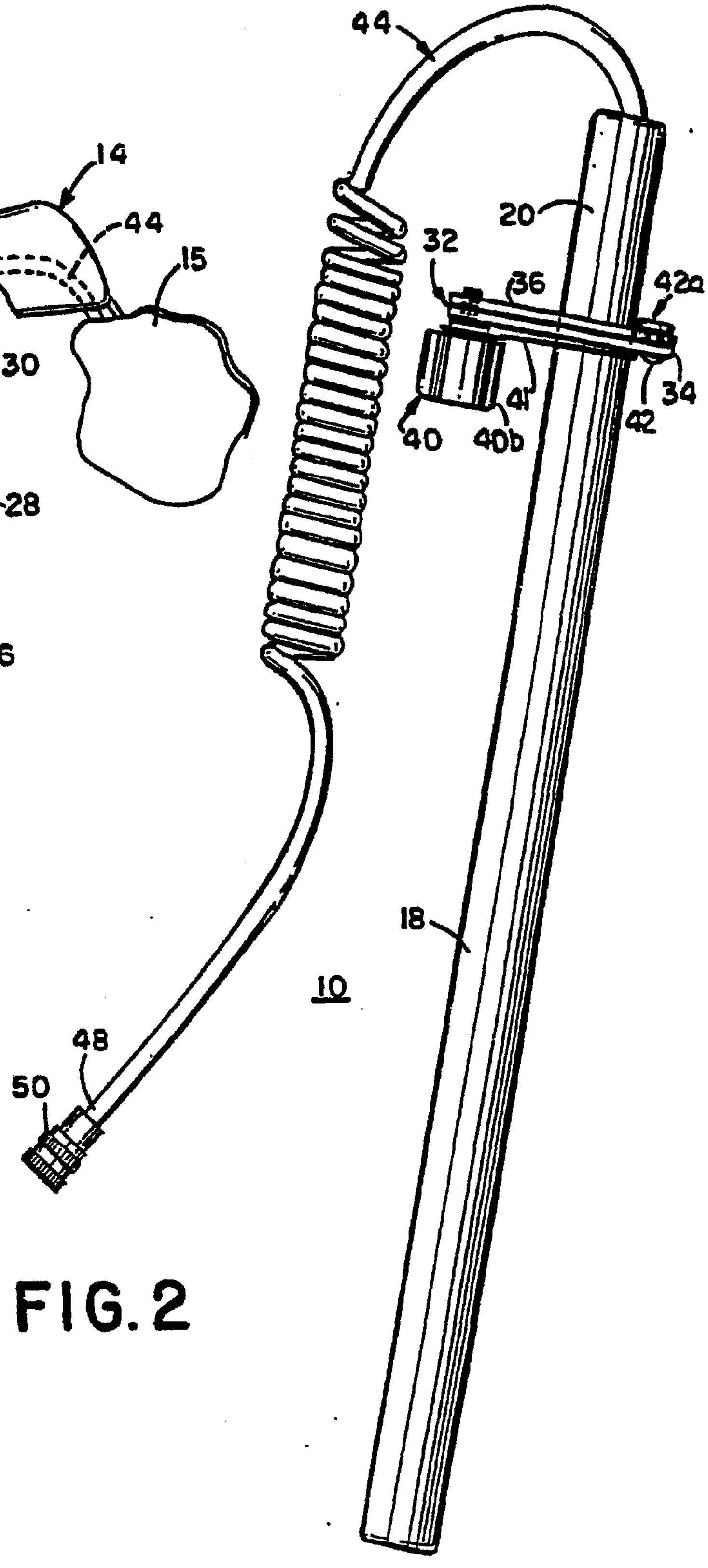
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FIG. 2

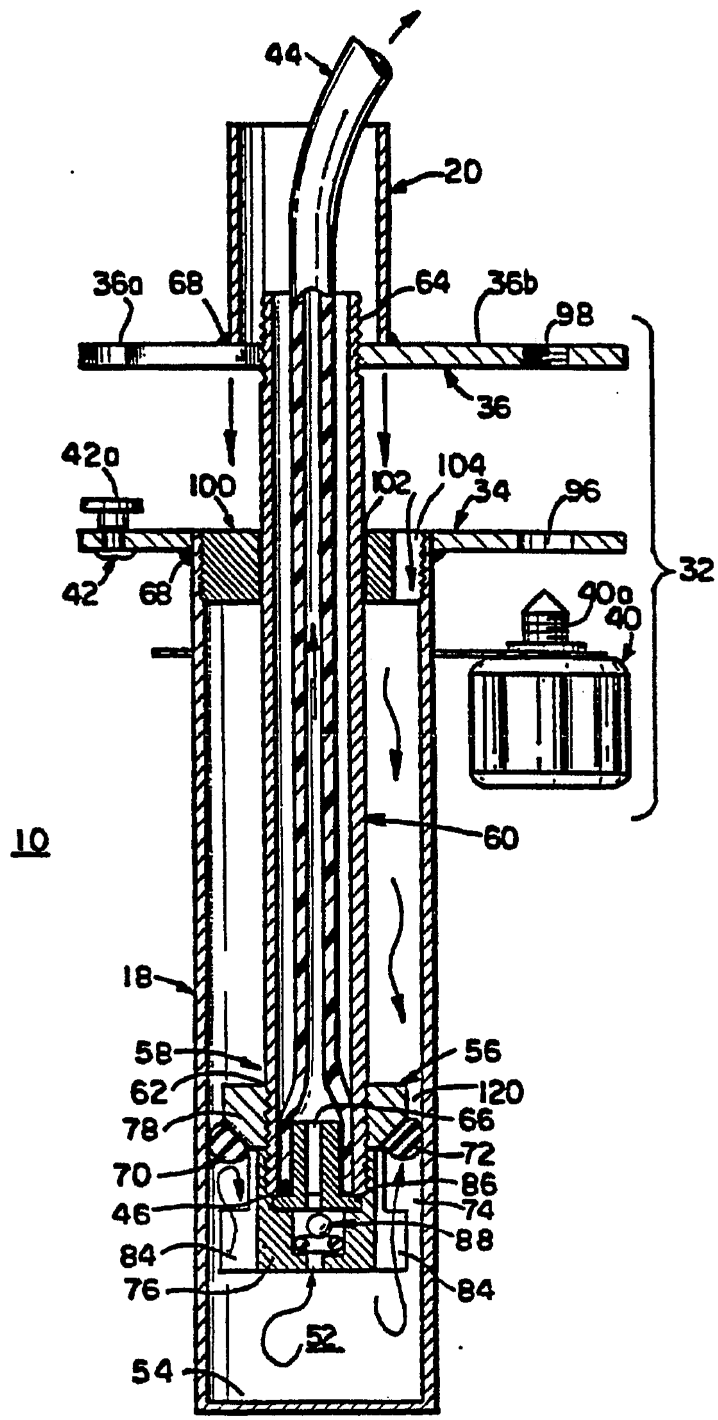
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FIG. 3

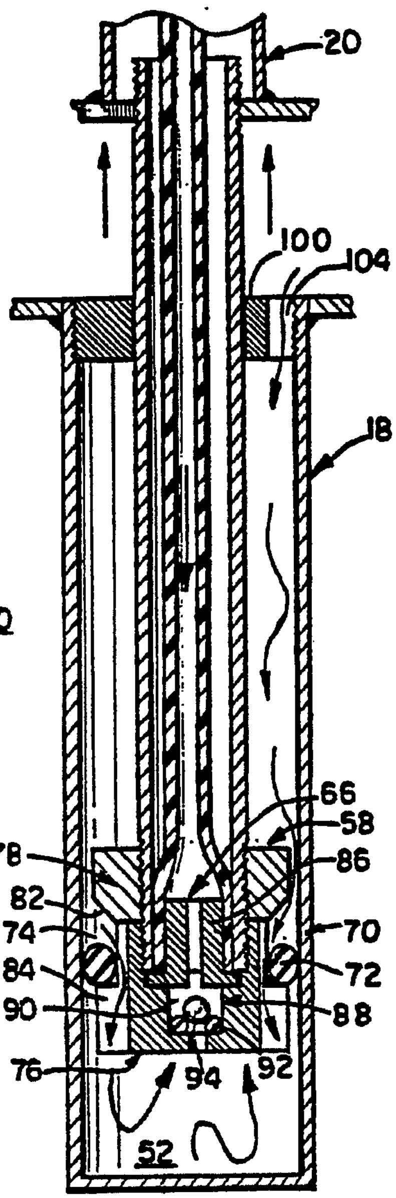
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FIG. 4

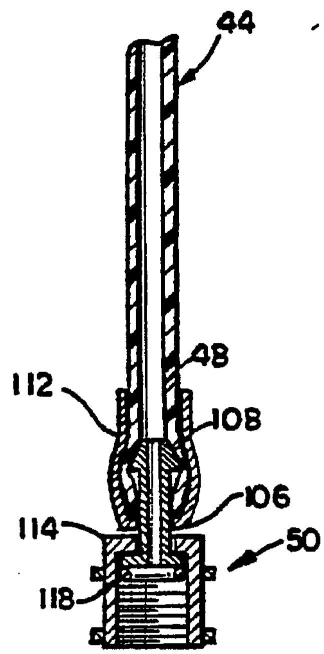
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FIG. 5

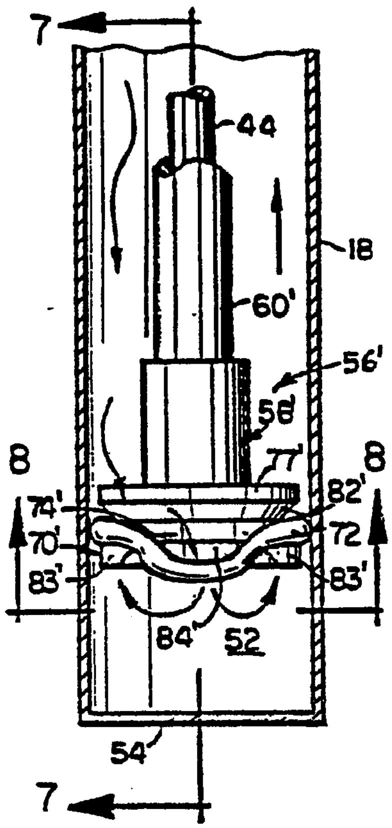

FIG.6

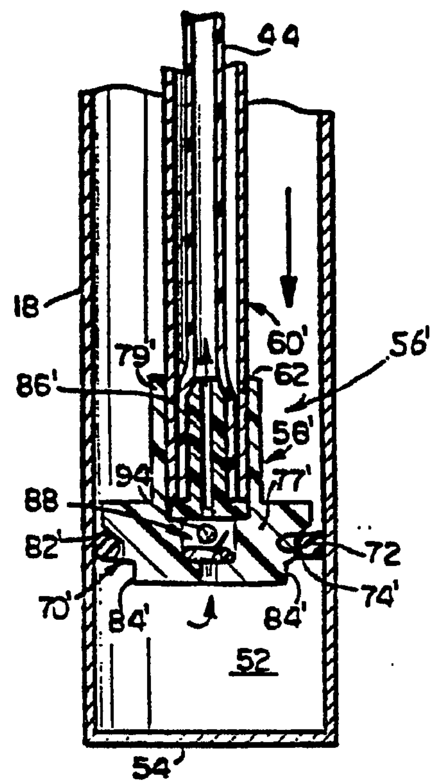

FIG.7

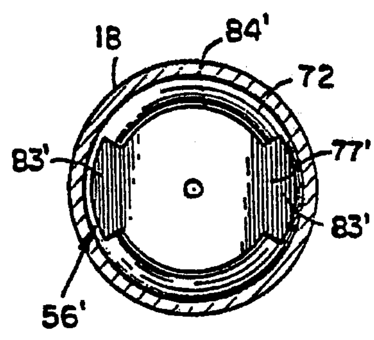

FIG.8

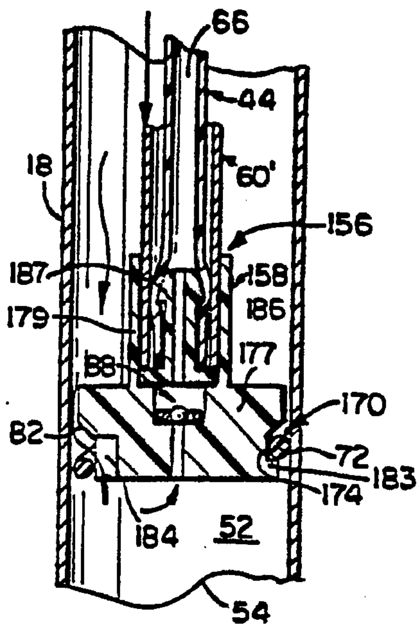

FIG. 9

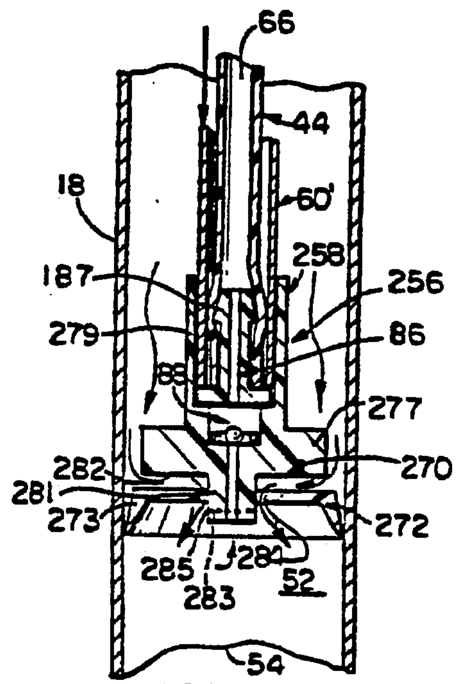

FIG. 11

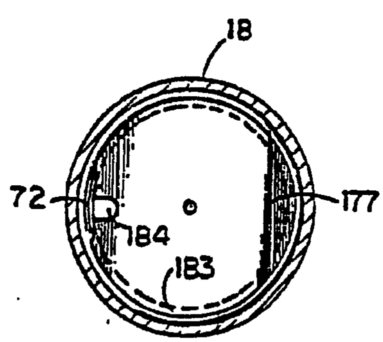

FIG. 10

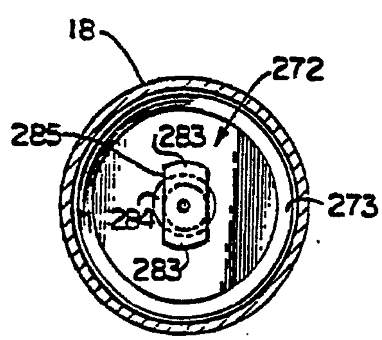

FIG. 12

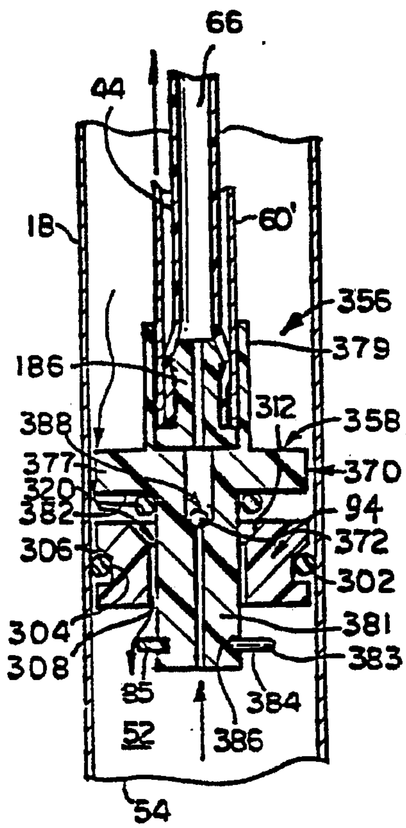
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FIG. 13

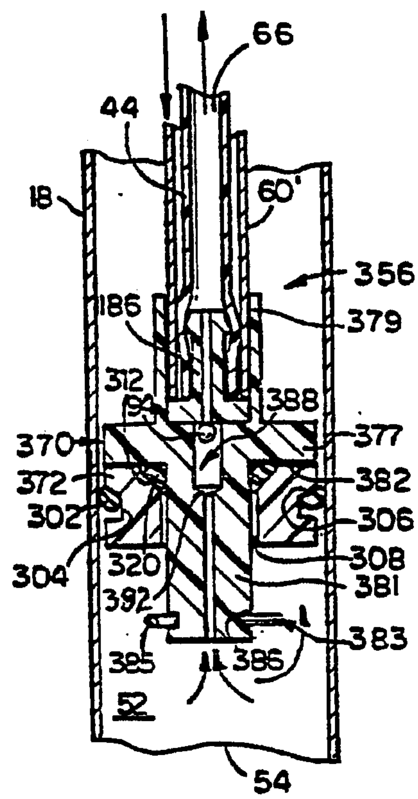
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FIG. 14

INTERNATIONAL SEARCH REPORT

International Application No PCT/US90/04172

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC (5): F04B 33/00
U.S. CL: 417/231

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
U.S. CL.	417/231,555.1,546,547,548; 280/201

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	US, A, 4,842,290 (ALIOTO) 27 June 1989	1,2,10
Y	US, A, 647,329 (ROBINSON) 10 APRIL 1900 (Note connector 5)	11
A	US, A, 2,901,980 (JORDAN) 01 September 1959	
A	US, A, 4,712,592 (BROWN) 15 December 1987	
Y	US, A, 4,773,305 (NISSELS) 27 September 1988 (Note figs 3-5)	12

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
22 AUGUST 1990	03 DEC 1990
International Searching Authority [1]	**Signature of Authorized Officer**
ISA/US	NGUYEN NGOC-HO INTERNATIONAL DIVISION for DAVID SCHEUERMANN Ngoc-Ho Nguyen

Form PCT/ISA/210 (second sheet) (May 1986)